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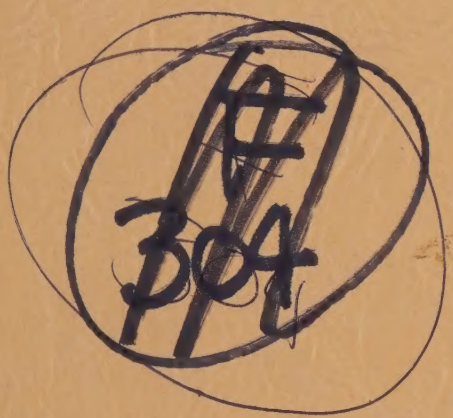
6C94

INSTRUMENT INSTRUCTIONS

UNIVERSAL
POLY RANGERS



SENSITIVE RESEARCH
INSTRUMENT CORPORATION
NEW ROCHELLE, N.Y.

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

Instrument No. 302464

00468

RETURN TO
CAPITAL EQUIPMENT SERVICES
BLDG 014

INSTRUCTION MANUAL

FOR

OPERATING AND MAINTENANCE

OF

A. C. and D. C.

UNIVERSAL POLYRANGERS

MODEL U-88, USP

TYPE D'Arsonval & Thermo Couple D'Arsonval

ACCURACY D.C. — .5 of 1%
A.C. — .75 of 1%

SCALE LENGTH 5.2 inches

Represented by
McCarthy Associates
441 W. California Ave.
Palo Alto, California
Phone: DAvenport 6-7937

Symbol of Quality

SENSITIVE RESEARCH
INSTRUMENT CORPORATION
NEW ROCHELLE, NEW YORK.

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

UNIVERSAL POLYRANGER

This instrument was designed in 1927 and its basic design has been unchanged since that time. Its 28 internal ranges in A.C. and D.C. still cover the large majority of value in current and voltage that are used today (30 years later.)

This UNIVERSAL POLYRANGER is a compact instrument designed to measure 14 ranges of D.C. and 14 ranges of A.C. current or voltage. Its accuracy of 3/4 of 1% on A.C. and 1/2 of 1% on D.C. is unusual in an instrument so versatile. RADIO FREQUENCY measurements can be made with the use of external vacuum thermo-couples in conjunction with the 5 millivolt range of the D.C. instrument side.

OPERATION OF THE UNIVERSAL POLYRANGER

The instrument consists of two separate electrical sections, one for D.C. and the other for A.C. measurements. A single D'Arsonval moving coil design is used and it is switched from D.C. to A.C. as required. The A.C. side uses a vacuum thermocouple to produce a small D.C. voltage which is created by the flow of current either A.C. or D.C. through its heater circuit. This D.C. millivoltage is accurately measured by the instruments D'Arsonval movement, when the "Circuit Selector Switch" is on its A.C. position.

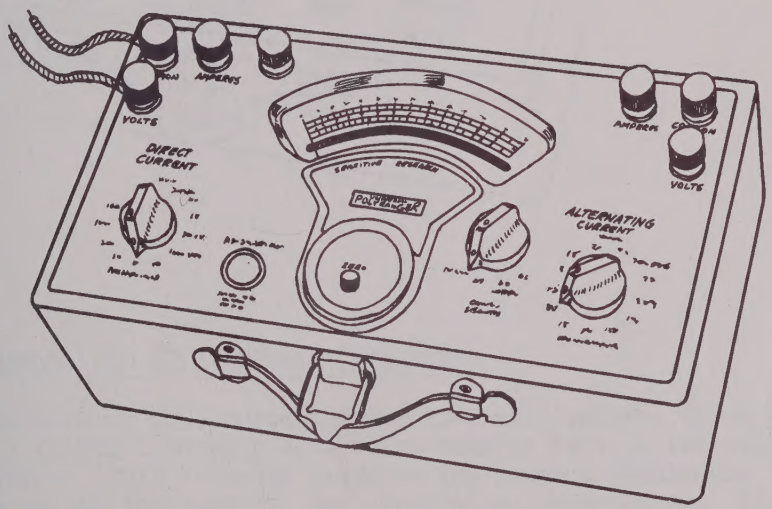
Since the two circuits are not connected to the moving coil at the same time, both A.C. and D.C. can be applied SIMULTANEOUSLY. Then by changing the circuit selector switch on the panel, the A.C. and the D.C. can be compared at the same time even though it is not considered good instrument practice.

The D.C. section is on the left side of the instrument panel, the A.C. on the right. When you receive the instrument you will notice that the instrument pointer is very sluggish. This is due to the "CIRCUIT SELECTOR SWITCH" being in its "TRANSIT" position. If switched to any other position, the pointer will act freely on D.C. and somewhat more damped on A.C. due to the thermocouple circuit.

We use "Diamond Pivots" and shock mounted jewels exclusively in these instruments. This is a revolutionary development in pivot construction, pioneered by our progressive engineering staff. Diamond pivots will withstand the tremendous impact of a three foot drop without deformation to either the pivot or jewel.

DIRECT CURRENT AND VOLTAGE BY SWITCH CONTROLLED RANGES

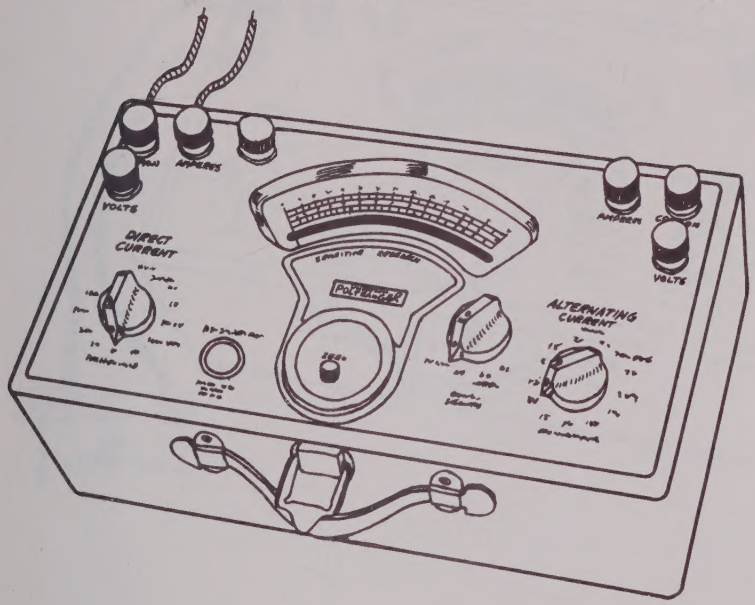
CONNECTIONS FOR
D.C. CURRENT & VOLTAGE
12 FULL SCALE RANGES (SWITCH CONTROLLED)
FROM 200 MICROAMPERES
TO 1000 MILLIAMPERES
AND FROM 50 MILLIVOLTS
TO 1000 VOLTS
CIRCUIT SWITCH ON D.C.



DC	
ACCURACY	.5 of 1%
SCALE	5.2"
PERIOD	3 seconds
SIZE	13¾"x7½"x6½"
WEIGHT	10 lbs.
TYPE	D'Arsonval Double Pivot
AC	
ACCURACY	.75 of 1%
SCALE	5.2"
PERIOD	6 seconds
SIZE	13¾"x7½"x6½"
FREQUENCY	See below →
TYPE	Vacuum thermocouple (Protected)

The internal A.C. ranges may be used just as accurately to measure D.C., and normally covers all frequencies up to 15,000 cycles on current up to 1 amp. and 5000 cycles on current above 1 amp.; also 5000 cycles for the voltage ranges with .75% accuracy. Should the A.C. thermocouple accidentally be burned out, the D.C. side will still function perfectly, an obvious advantage.

CONNECTIONS FOR
2 AMPERES D.C.
FULL SCALE
SINGLE RANGE ONLY
SELECTOR SWITCH IN
ANY POSITION
CIRCUIT SWITCH ON D.C.



D.C. CURRENT ABOVE 1000 MILLIAMPERES (1 AMPERE)

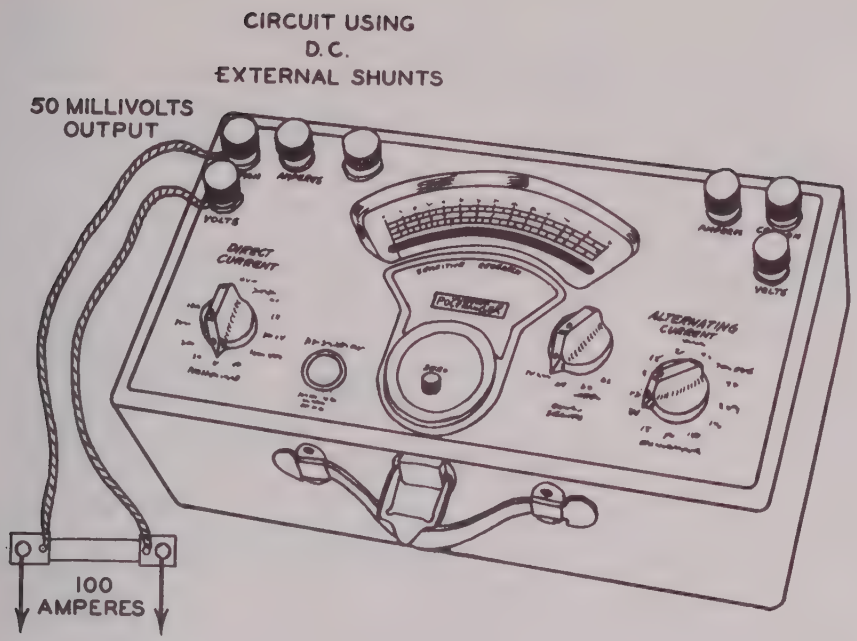
For measurement on D.C. current above 1000 milliamperes (1 ampere) we use the D.C. COMMON binding post and the binding post to its right engraved 2 AMPERES. This 2 ampere range is the highest obtainable internal range in the instrument. See connections shown above. If the necessity arises to measure current above 2 amperes then we suggest the use of external shunts of 50 millivolt drop and the Universal Polyranger with the CIRCUIT SWITCH on D.C. and the range switch on 50 millivolts.

EXAMPLE:

Assume we have a 100 ampere 50 M.V. external shunt connected as shown below. Then 100 D.C. amperes through the shunt will cause the Polyrange to read 50 MILLIVOLTS full scale.

50	MILLIVOLTS =	100	AMPERES	
40	"	80	"	
30	"	60	"	etc.

By using selected 50 millivolt shunts there is really no upper limit to the ranges of D.C. current obtainable.



HIGH D.C. VOLTS

The D.C. voltage circuit of the Universal Polyranger is exactly 1000 ohms per volt. This means that if voltages above 1000 volts must be measured then a series resistance can be connected in series with the CURRENT-VOLTS binding post.

The necessary series resistance can be readily calculated.

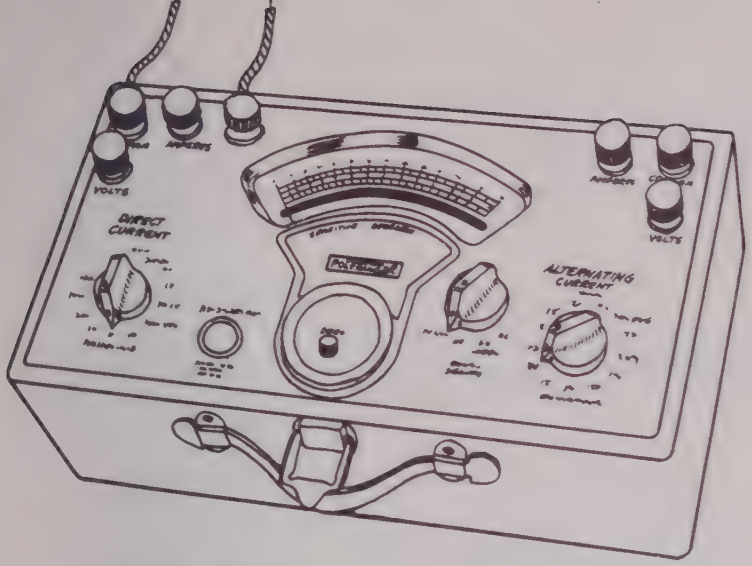
FOR EXAMPLE:

We wish to measure 5000 Volts D.C. Using OHM'S LAW;

$$R = \frac{E}{I} = \frac{5000}{.001} = 5{,}000{,}000 \text{ Ohms}$$

(current at 1,000 ohms per volt)

as there is 1,000,000 ohms in the instrument selector switch or (1000 Volts at 1000 Ohms per Volt) we will only need a series resistance of 4,000,000 ohms that will carry 1 milliampere and stand 4000 volts. In like manner any D.C. high voltage can be measured provided precautions are taken and that the Universal Polyranger is always used in the ground or "low side" of the high voltage circuit.



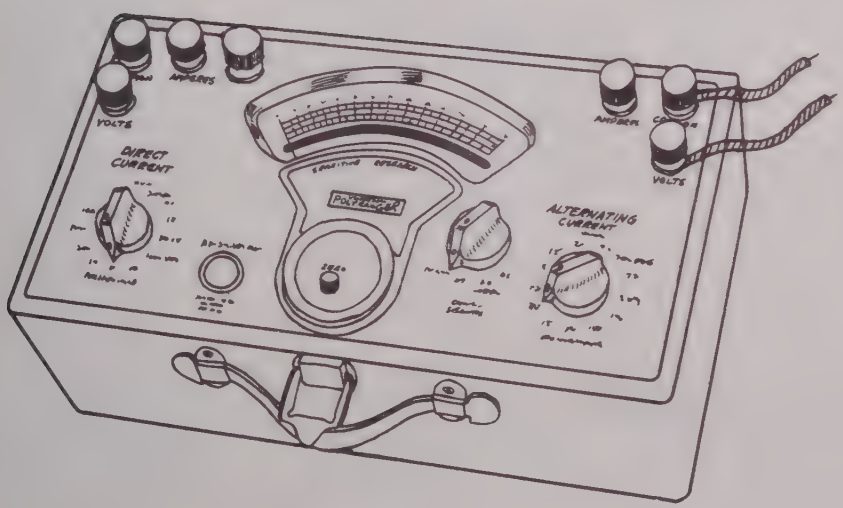
CONNECTIONS FOR
5 MILLIVOLTS D.C.
SINGLE RANGE ONLY
SELECTOR SWITCH IN
ANY POSITION
CIRCUIT SWITCH ON D.C.

A.C. CURRENT AND VOLTAGE MEASUREMENTS

A.C. CURRENT

For A.C. measurements the "CIRCUIT SELECTOR SWITCH" MUST pass through a "SAFETY POSITION" before it reaches the A.C. reading position. This prevents any accidental burnout in changing from D.C. to A.C. Use the binding posts as shown on picture below.

CONNECTIONS FOR
A.C. CURRENT OR VOLTAGE
13 FULL SCALE RANGES (SWITCH CONTROLLED)
FROM 15 MILLIAMPERES
TO 1500 MILLIAMPERES
AND FROM .3 VOLT
TO 750 VOLTS
CIRCUIT SWITCH ON A.C.



Using the above connections D.C. or A.C. current may be measured from 15 milliamperes full scale (lowest reading 3 milliamperes to 1500 milliamperes full scale lowest reading 300 milliamperes A.C. or D.C. voltage may also be measured whose ranges are chosen by the range selector switch position.

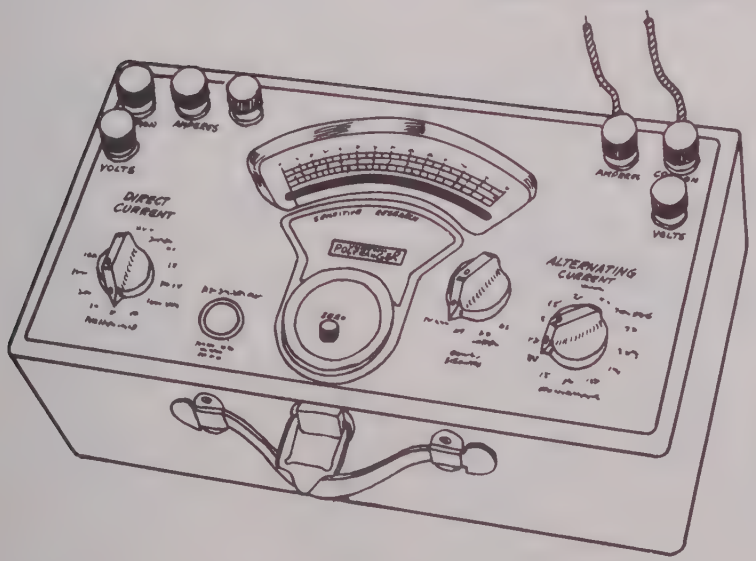
A.C. VOLTAGE

The same Binding Posts are used as shown above, voltage ranges may be obtained from 300 millivolts (.3 volt) full scale lowest reading 60 millivolts (.06 volt) to 750 volts full scale lowest reading 150 Volts (at 100 ohms per volt)

HEAVY A.C. CURRENT

The Universal Polyranger has a heavy current range of 3 amperes that is obtained by use of the A.C. common binding post and a separate post to its left engraved 3 AMPERES.

CONNECTIONS FOR
3 AMPERES A.C.
SINGLE RANGE ONLY
SELECTOR SWITCH IN
ANY POSITION
CIRCUIT SWITCH ON A.C.



Should the occasion arise heavier A.C. currents can be measured using special external shunts that must be made to order having a .3 volt drop for their designed current rating. This .3 volt drop would be measured using the .3 volt selector switch position with the "CIRCUIT SELECTOR" on its A.C. position together with the proper scale divisions.

HIGH A.C. VOLTAGE MEASUREMENTS

Similiar to the D.C. side of the Universal Polyranger we can measure high voltages on A.C. by using a series resistance and the highest volt (7500 Ohm) circuit of the POLYRANGER

Using OHM'S LAW $R=\frac{E}{I}$ and knowing that the voltage circuit is 100 ohms per volt (or a full scale current of 10 milliamperes (.01 ampere) then assume we wish to measure 3000 Volts A.C.

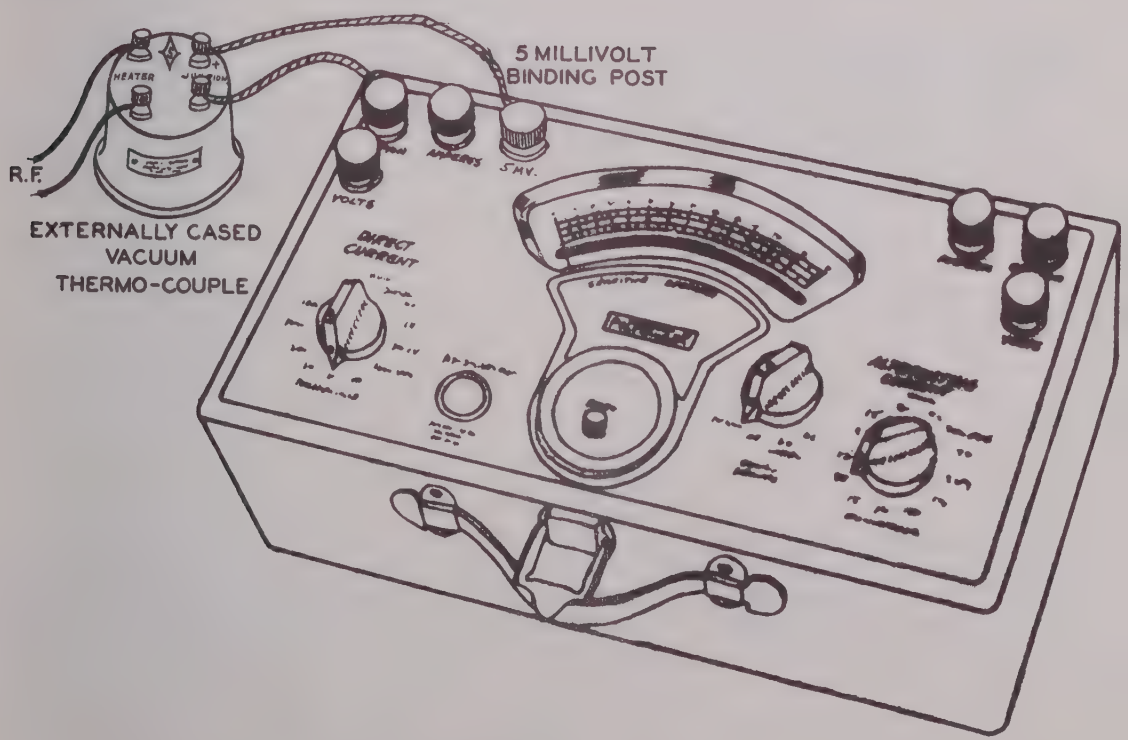
$$R=\frac{E}{I}=\frac{3000 \text{ Volts}}{.01 \text{ (Current Drain)}}= 30000 \text{ Ohms}$$

The Polyranger selector switch to be on 750 volts, its circuit has a resistance of 7500 ohms. (Current drain 10 milliamperes.)

Then 30000 Ohms
-7500 Ohms (instrument resistance)
22500 Ohms series resistance necessary to measure 3000 volts.

3000 Volts would cause a current flow of 10 milliamperes and the 30 full scale point on the instrument would be considered as 3000 Volts
28 = 2800 Volts
24 = 2400 Volts Etc.

RADIO FREQUENCY MEASUREMENTS



Using "Sensitive Research" external vacuum thermocouples, (see picture preceeding page.) Measurements may be made in R.F. up to 10 megacycles by the proper selection of thermocouples.

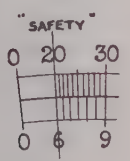
Using a suitable resistance in series with the thermocouples R.F. measurements in voltage may be readily made, keeping in mind that the heater resistance (supplied with every SENSITIVE RESEARCH thermocouple) must be allowed for in voltage circuit calculated by OHM'S LAW and this resistance subtracted from the total calculated resistance (See methods on preceeding pages.)

THERMO-COUPLE AND INSTRUMENT PROTECTION

The Universal Polyranger has an automatic safety protection that operates when CIRCUIT SWITCHING from D.C. to A.C. We also have a finger operated safety key.

To date it has not been found practical to protect a VACUUM THERMO-COUPLE by any method of fusing, due to the high resistance that low current capacity fuses insert in the instrument circuit. Therefore we have as standard equipment a protective device, developed by ourselves, which will protect the Thermo-Couple in this instrument to a 1000% overload. Thermo-Couples without protection will just withstand 100% overload before burning out.

Briefly explained, it consists of a finger-operated push button mounted on the panel surface, correctly adjusted shunts and a red safety line drawn on the instrument scale. When the safety is on, it shunts 4/5 of any applied current around the heater of the Thermo-Couple. Normal heater current will then only give a scale deflection of 1/5 reading.



At this point on the A.C. instrument scale, a red line is drawn marked "Safety." Therefore, if when the instrument is put on test, it reads ABOVE the red line, it indicates that the instrument if being overloaded. Current should therefore be reduced until pointer reads below red line. Button is then depressed and the instrument reads the actual current or voltage.

The Safety Shunt is so compensated that its operation does not change the instrument resistance or affect any external circuit. The use of this device very materially reduces the upkeep cost which is an item in any laboratory.

MAINTENANCE

The Universal Polyranger has two very advanced instrument design features that add very materially to its usefulness. These are described below.

AUTOMATIC TEMPERATURE COMPENSATION

Ever since thermocouple instruments have been made (1890), they have had a very poor temperature coefficient. In most cases it was .2 of 1% per degree Centigrade. If the instrument was used at temperatures that varied more then ± 4°C from the usual standardizing temperature of 25°C, it would read out of its guaranteed accuracy. This meant that a temperature coefficient correction factor 1 + .002 (T-25°C) x reading must be applied.

Our UNIVERSAL POLYRANGER is now equipped with an automatic temperature compensation network which reduces the temperature coefficient so low that temperature errors on both A.C. and D.C. are practically undiscernible at temperatures between 20°C and 30°C.

REPLACEMENT THERMOCOUPLES

The THERMOCOUPLE REPLACEMENT FEATURE permits the user to replace burned out thermocouples in the field and still retain full instrument accuracy. A special compartment at the bottom of the instrument case allows access to the thermocouple and its associated calibrated resistors.

The SRIC thermocouple replacement feature is of the 4-solder joint type which eliminates the possibility of undesirable contact resistances developing at some future time. To change thermocouples, remove the molded cap, by removing 3 oval head machine screws. Unsolder the old thermocouple and its resistors. Solder in the new thermocouple and the resistors supplied with it. (Black leads are heater wires, the red lead is the plus junction wire, and the green lead is the minus junction wire.) Replace the molded cap. The above operation is relatively simple and requires only a few minutes time. Inasmuch as the output characterstics of individual thermocouples vary a few percent within a particular type, a deviation curve is supplied with the new replacement thermocouple. The use of this correction curve with the original instrument scale will permit all readings to be taken within the instrument's guaranteed accuracy.

UNIVERSAL POLYRANGER

MODEL USP

INTERNAL RANGES

D.C. RANGES

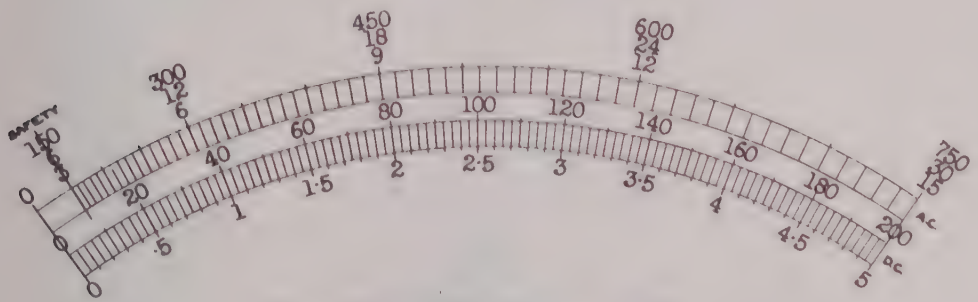
CURRENT	VOLTAGE
	Resistance 1000 ohms per volt
0 - 200 Microamperes (lowest reading 2 microamperes)	0 - 5 Millivolts } use separate binding post (For Vacuum Thermo-Couple use)
0 - 2 Milliamperes	0 - 50 Millivolts } for use with external shunts
0 - 20 Milliamperes	0 - 100 Millivolts
0 - 200 Milliamperes	0 - 500 Millivolts
0 - 1000 Milliamperes	0 - 2 Volts
0 - 2 Amperes	0 - 20 Volts
	0 - 200 Volts
	0 - 1000 Volts

A.C. RANGES

CURRENT	VOLTAGE
	Resistance 100 ohms per volt
0 - 15 Milliamperes (lowest reading 3 milliamperes)	*0 - .3 Volt
	0 - 1.5 Volts
0 - 30 Milliamperes	0 - 3 Volts
0 - 150 Milliamperes	0 - 15 Volts
0 - 300 Milliamperes	0 - 30 Volts
0 - 1500 Milliamperes	0 - 150 Volts
0 - 3 Amperes	0 300 Volts
	0 - 750 Volts

* May be used with external shunts

Diagram Page 149



TYPICAL POLYRANGER SCALE—FULL SIZE

We have built in quantity, three (3) special variations of the basic design of the Universal Polyranger Model USP described above.

The Universal Polyranger our Model U (Not Model USP or U-SP) is equipped with a 3 position rotary switch or toggle switch for AC - DC circuit selection. (See circuit diagram.) (Pages 150 - 151)

Another Universal Polyranger Model U-SP was specially designed to meet USA Government military specifications. (Part No. USAFUSP.) Its ranges are similar to the Model U except it has 3 additional ranges on direct current of 40 and 400 volts, together with a 20 ampere range on separate binding posts. It uses our design 3 position rotary circuit selector switch. (Circuit diagram page 152.)

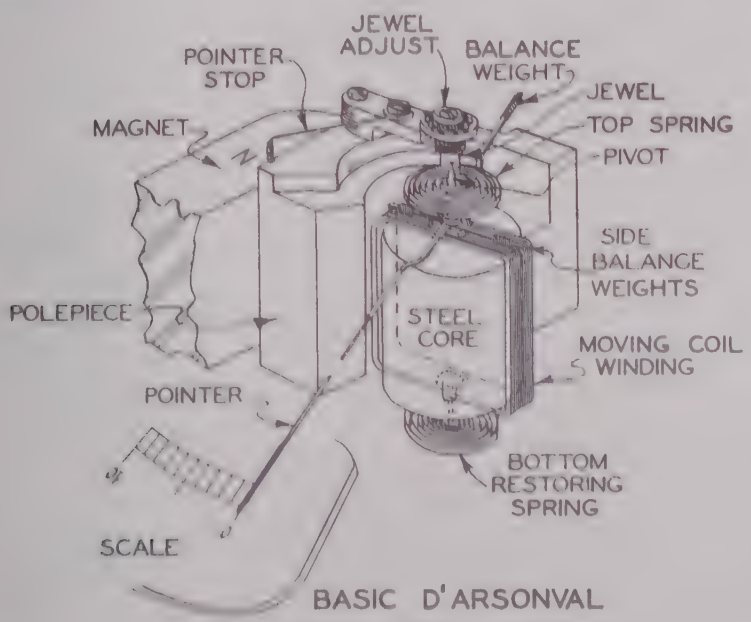
ELECTRICAL MEASURING INSTRUMENTS

D. C. CURRENT MEASUREMENTS

Almost all electrical measurements involve the detection or measurement of an electric current. An electric current can be measured by means of one or more of its physical effects;

1. Heating Effect
2. Chemical Effect
3. Magnetic Effect

Using the magnetic effect caused by a current flow, we can devise an accurate means of measurement. The oldest design of such a device is known as the D'Arsonval Moving Coil System. An elementary sketch of which is shown below.



BASIC D'ARSONVAL MOVING COIL ASSEMBLY

Its operation depends on the force exerted on a current carrying conductor shaped in a coil which is capable of rotation in the field of a permanent magnet.

When a D.C. current flows through this rotatable coil, it creates a field which interacts with the permanent magnet field and produces a torque.

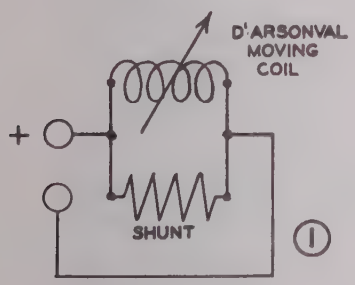
This torque is proportional to the magnet strength, the current in the moving coil and the number and area of the moving coil turns. The torque produced rotates the moving coil until its spiral springs are wound up sufficiently to produce an equal and opposite torque. When this point is reached the pointer deflection will be directly proportional to the current which produced it.

Essentially a D'Arsonval moving coil which in Sensitive Research Instruments, is rectangular in shape has a steel or diamond pivot at each end which turns in spring mounted jewel bearings.

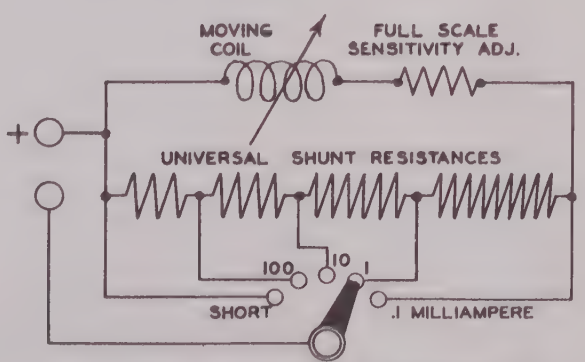
The D.C. current enters and leaves the moving coil usually through spirally constructed phosphor bronze springs which are coiled in opposite directions. These springs also provide the controlling force which opposes the deflecting force created by the current flow through the moving coil turns.

The accuracy of such an assembly to date is superior to any other known type of current deflected mechanism for electrical measuring instruments.

As such a moving coil system will not usually carry over 30 milliamperes without heating errors we shunt any additional current past the moving coil. By calculated and accurately constructed shunts either singly or in a multiple system, we can measure D.C. currents of large magnitude even through the moving coil is only carrying and measuring 30 milliamperes or less. (See circuits below)



SHUNTED INSTRUMENT



MULTIRANGE D.C. CURRENT ② INSTRUMENT
.1-1-10-100 MILLIAMPERES

SENSITIVE RESEARCH has developed and improved during the past 31 years, the basic D'Arsonval moving coil system so that today we use it even in our 1/20 of 1% LABORATORY STANDARD D.C. Instruments.

A D'Arsonval moving coil system will accurately measure when properly constructed very minute D.C. currents down as low as .01 of one microampere (.00000001) ampere, and indicate this small magnitude of current by a pointer on an indicating scale drawn in divisions-deflection. This extreme high sensitivity is unusual in portable indicating D.C. instruments.

D.C. VOLTAGE MEASUREMENTS

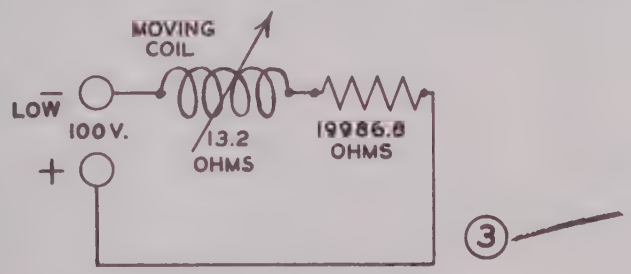
The D'Arsonval moving coil system movement, is a current measuring device but by following a principle of ohms law we can use this current measuring movement to measure D.C. voltage.

FOR EXAMPLE:

Assume we wish to measure 100 volts direct current. Also assume that we have a D'Arsonval movement that deflects full scale for 5 milliamperes with a resistance of 13.2 ohms. By Ohms Law 100 volts across a circuit of 20000 ohms will have a current flow of 5 milliamperes (.005 amperes) by:

$$R = \frac{E}{I} = \frac{100 \text{ Volts}}{.005 \text{ Amperes}} = 20000 \text{ Ohms}$$

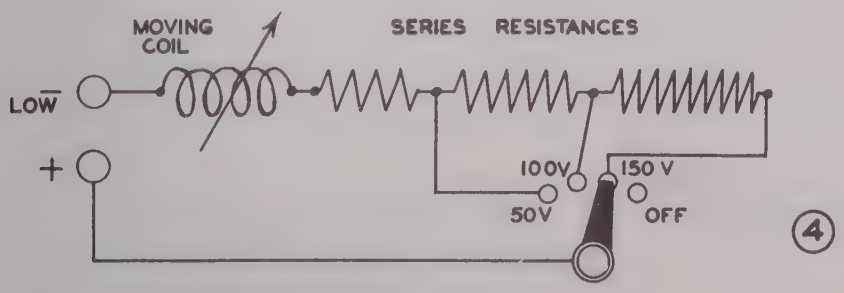
Now if we place our D'Arsonval moving coil (13.2 Ohm), in the circuit in series with 20000 Circuit Ohms-Less 13.2 Moving Coil Ohms-Equals 19986.8 Ohms.



SIMPLE
SINGLE RANGE VOLTMETER
100 VOLTS

Then a potential of 100 D.C. volts will cause a current of 5 milliamperes (.005 Ampere) moving coil pointer deflection can be calibrated and marked on the scale as 100 Volts.

Using the ohms law formula and suitable calculated resistances we can readily construct multirange D.C. Voltmeters.



MULTIRANGE D.C. VOLTMETER
50-100-150 VOLTS

GENERAL INFORMATION

Upon receipt, your instrument should be carefully unpacked and examined for any visible external damage, i.e; split case, cracked glass, broken binding posts, etc. Place the instrument on a reasonably level bench. If the instrument has a wire shunting (across) the terminals, it should be removed. With the mechanical zero adjuster thumb knob, move the pointer both above and below the zero line of the scale. It should have sufficient travel to go a little beyond zero in each direction. Set the pointer exactly on zero while lightly tapping the instrument case with your fingers. The pointer will be correctly adjusted for zero when no reflection of the pointer's knife edge can be seen in the anti-parrallax mirror and the pointer is directly over and in line with the scale zero.

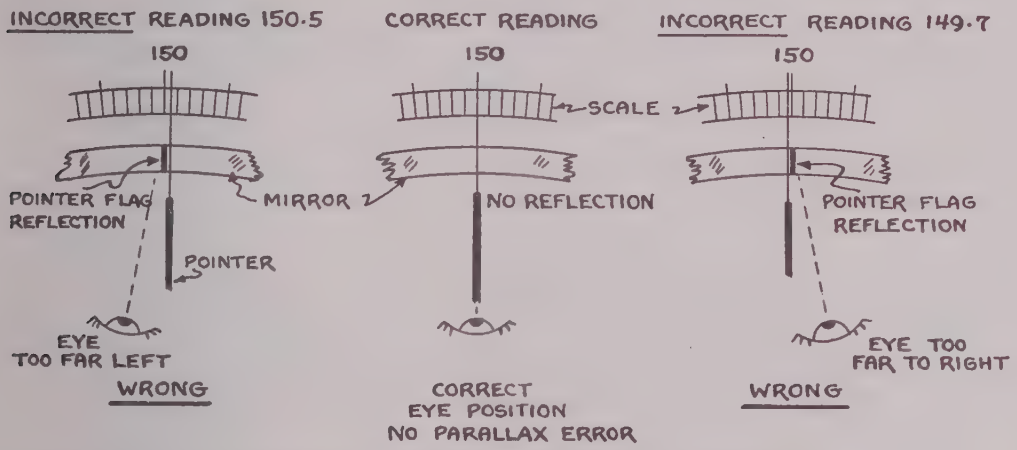


ILLUSTRATION OF THE ANTI-PARALLAX PRINCIPLE

The pointer indication should only be "read" when no reflection of its knife edge can be seen in the mirror below. This is only obtained when the eye is directly over the pointer. The drawings above illustrate the anti-parallax principle.

BALANCE TESTS FOR DIRECT CURRENT INSTRUMENTS

The general testing procedure for balance on all portable and panel instruments is the same, the difference being only in the degree of angle that the instrument is tipped from a horizontal position.

1. See that the pointer is set exactly on its zero position.

2. Now tip the instrument slowly up from the side farthest from you to an angular position as shown on the table below, and tap gently. The pointer should NOT move more than the amount shown on the table below.

3. Next, lay the instrument flat again and then tip it on its side, both left and right, and tap gently.

In both of these procedures, the instrument should be within its balance specifications. In general, these specifications are as follows:

DIRECT CURRENT INSTRUMENTS

MODEL	ACCURACY	ANGLE FROM HORIZONTAL	BALANCE GUARANTEE
UPP PANEL	.5 of 1%	90°	.5 of 1%
UP PANEL	1%	90°	.5 of 1%
J,JW,S, UNIVERSITY PORTABLE	.5 of 1%	25°	.5 of 1%
C PORTABLE	.25 of 1%	25°	.25 of 1%
B LAB. STANDARD	.1 of 1%	10°	.1 of 1%

FRICTION TESTS

The instrument may be tested for mechanical friction at this point, by connecting it to a suitable source of power and deflecting it at least 25% of full scale, then reducing the deflecting current to zero. No instrument should be accepted for use if it has any appreciable friction.

CALIBRATION CHECK

No actual calibration check should be made until the instrument has become thoroughly temperature saturated at ambient room temperatures for at least four hours. (Allowed to reach room temperature.) SENSITIVE RESEARCH calibrates all instruments at exactly 25° C.

Make sure you are on the right range for your power supply. If in doubt set the range switch if any, on the instrument, on its highest range. This will prevent overloading of the instrument when starting any electrical tests. If only a slight pointer deflection results when power is applied, then successively switch the instrument range selector DOWN until a suitable reading is obtained. Bring the pointer up to full scale and open the instrument circuit. A special precaution should be taken by the user of thermocouple instruments, and that is to AVOID opening the primary circuit of a transformer whose secondary circuit is being measured by thermocouple instruments. The reason for this is that the transformer as an energy storing device, may, under certain conditions, DISCHARGE its energy into the secondary circuit, thereby overloading the thermocouple instrument. (Overloads of 1000% are quite possible in transformer circuits.)

This danger can be eliminated by either disconnecting the instrument from the secondary circuit which can be turned to "zero" so that the excitation of any transformer primary may be reduced to "zero" before switching off.

The pointer should return to its original zero without tapping. If it returns to zero only when tapped, it indicates friction in the movement and possible damage to the pivots and jewels, possible through some severe shock in transit. For portable instruments with an overall accuracy of .5 of 1% or higher, and all high torque panel types, the pointer should return to exactly zero. Ultra high sensitivity instruments in the 1% class, and thermocouple instruments in the .75 of 1% class should have a maximum deviation from zero to no more than .1 of 1% of the physical length of the scale.

The pointer should then be deflected using controlled power slowly up and down the instrument scale. The pointer action should be smooth and there should be no sticking or hesitation at any point on the scale. Do not, however, mistake a rough spot in the controls of your power supply for a "stick" in the movement. Often, a badly regulated power supply or a loose circuit connection may make the instrument appear to have an internal variable. All instrument links and leads should be carefully attached and tightened.

The new instrument should be checked against an accurate standard on the cardinal points of the scale. Just one word of CAUTION. Be careful that you do not place your new instrument and your standard too close together, especially with D.C. instruments. They may react magnetically on each other if your standard instrument is not magnetically shielded, it might indicate incorrect readings. Keep them at least six inches apart. Also, if the instrument was specially ordered for use on a steel panel (such information is printed on all our scales) then test it on a steel panel of the specified thickness.

Of all the things, that may be wrong when you get a new instrument, incorrect calibration is the LEAST likely; and if present at all, it will usually be caused by bad balance which you will already have detected by the test just covered. 99.99% of the instruments you receive, if they are satisfactory for balance, friction, stickiness etc., will also be well within their guaranteed accuracy.

NOTE:

Disassembly of the movement should not be attempted unless a skilled instrument man with calibration and scale drawing equipment are available.

CARE AND MAINTENANCE

All SENSITIVE RESEARCH instruments are individually assembled by skilled instrument makers and are INDIVIDUALLY calibrated. We do not calibrate instruments "en masse". Extreme care has been used in selecting pivots and shock mounted jewel bearings. In some instruments DIAMOND PIVOTS are used.

The instrument should be used and treated as a precision standard. A reasonable amount of care will bring its reward in a lifetime of accurate service.

Good practice dictates that periodic checks be made for pivot friction, coil, balance, scale calibration, and the mechanical integrity of any instrument.

If the instrument glass is cleaned by any method, the task should be completed by heavily breathing upon the glass so as to dissipate any electrostatic charges that may have been generated by friction. Occasionally the binding posts metal contact surfaces should be cleaned and brightened by the careful use of a fine sandpaper. A yearly coat of wax on any wooden instrument case is suggested.

Instrument panels are cleaned by using carbon tetrochloride to dissolve any greasy surface accumulations. A brisk rubbing with a soft flannel cloth will restore our moulded panels to their original lustre. Should the engraving "white" become discolored it can be removed with a sharp point and refilled with a white wax crayon material obtained from us.

OPERATIONAL PROCEDURE

1. Place the instrument on a level surface so that the scale is horizontal. Deviations of more than 5° from the horizontal may affect accuracy adversely.

2. For good instrument practice, the instrument should be kept away from any source of very strong magnetic fields. Maximum tolerable field is 5 oersted.

3. Set the pointer on zero by rotating the zero shifter, using thumb or zero screw. The pointer is correctly set on zero when the reflection of the pointer in the antiparallax mirror coincides with the pointer itself and with the zero line. (See general information sheets.) Page 4

4. For safety it is best to turn off the current or voltage to be measured before making connections to any instrument. Observing proper polarity, connect the instrument terminals in series with the circuit if current is to be measured.

   If voltage is to be measured then the voltmeter is to be in parallel to the portion of the circuit desired. It is important to remember that when an ammeter (current measuring instrument) is inserted in series with a circuit, the circuit is changed by the introduction of the ammeter resistance. Ammeters are therefore designed to be of low resistance so that they will only be a small fraction of the total resistance of a circuit.

   Remember also that when a voltmeter is connected across (in parallel) with a portion of a circuit it changes the potential difference by its own effect on the circuit and since it also is connected in parallel with a part of the circuit it reduces the effective resistance of that portion which increases in some degree the total current flowing in the complete circuit.

   Therefore voltmeters are designed to have the highest resistance possible so as not to change materially any circuit to which they may be applied.

5. It is considered good instrument practice in multirange instruments to have the range switch on the highest possible range and then the user can progressively switch down to the range that produces an acceptable reading. A good acceptable reading would be one in which the pointer is indicating in the upper fifth of the scale. (Nearly maximum deflection. Apply power and observe pointer deflection. When the instrument pointer has come to rest, the current is indicated by the position of the pointer on the scale.

6. After the desired measurements have completed, turn off the current supply and disconnect the instrument terminals from the source of current. If the instrument leads are left connected and circuit changes made damage could result to the instrument being on a range setting lower than the newly applied power value.

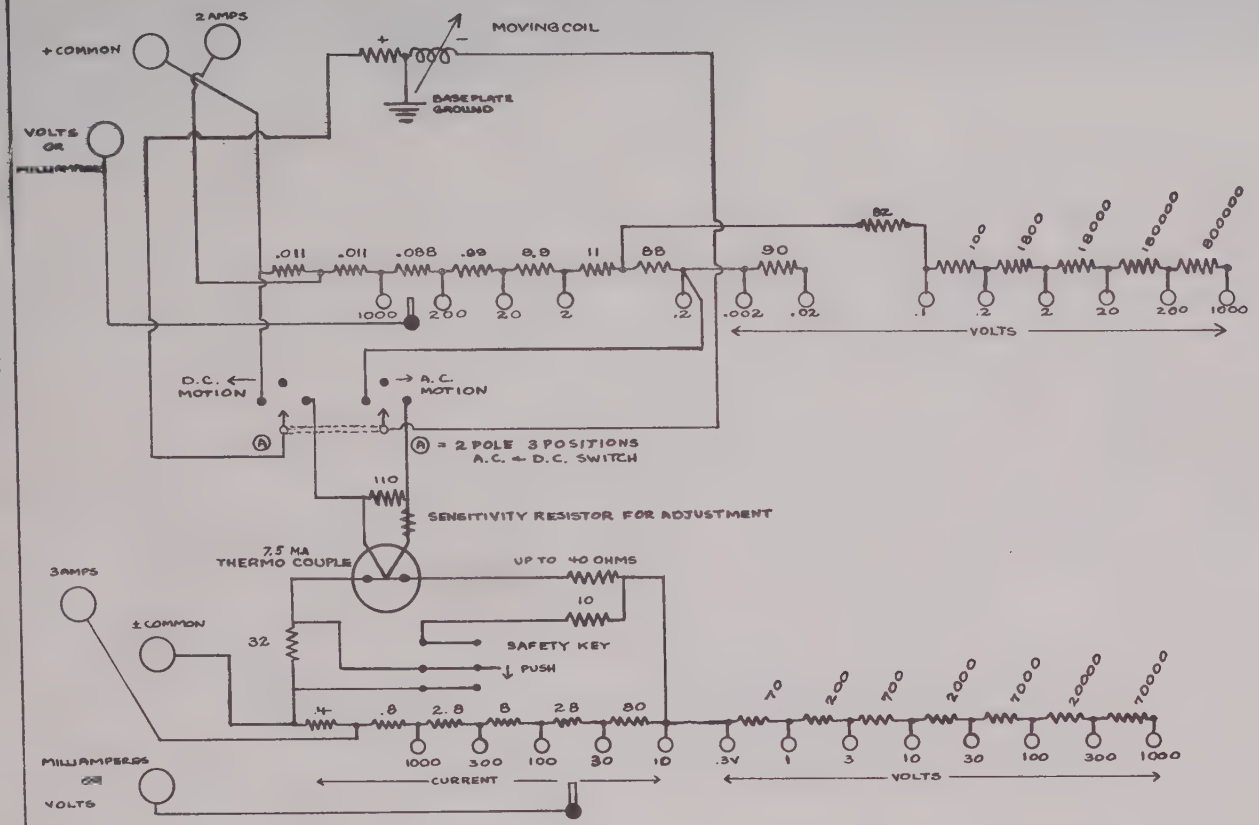
SENSITIVE RESEARCH INSTRUMENTS have a data card attached to it or mounted in its case. This data card detailing the accuracy and electrical characteristics together with the instrument panel engraving will readily enable the user to operate our instruments to their full accuracy and their personal satisfaction.

OLD DESIGN STANDARD

UNIVERSAL A. C.~ D. C. POLYRANGER

WITH 3 POSITION ROTARY SWITCH FOR A.C.—D.C. CIRCUIT SELECTION

MODEL U
WITH ROTARY SWITCH
CIRCUIT SELECTOR



DEL: P.A.C. FEB. 28, 1956

MODEL U

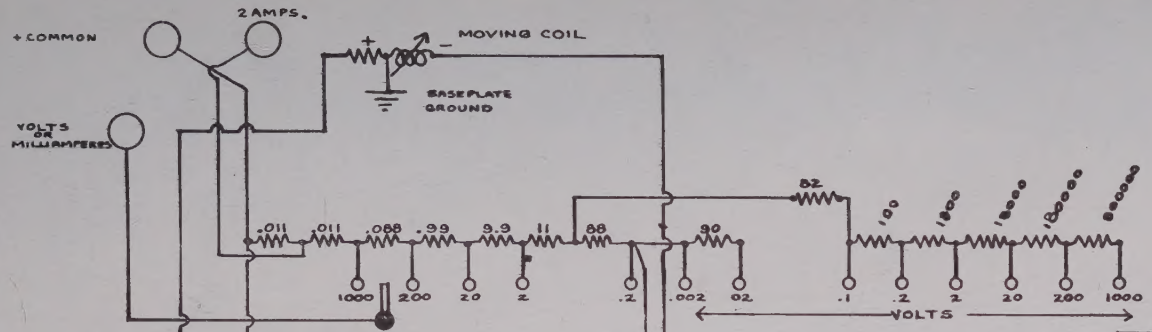
WITH TOGGLE SWITCH
CIRCUIT SELECTOR

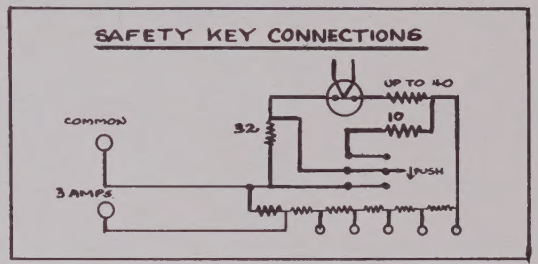
OLD DESIGN STANDARD

UNIVERSAL A.C.–D.C. POLYRANGER

WITH TOGGLE SWITCH

FOR A.C.–D.C. CIRCUIT SELECTION





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DEL- P.A.C. FEB. 25, 1950